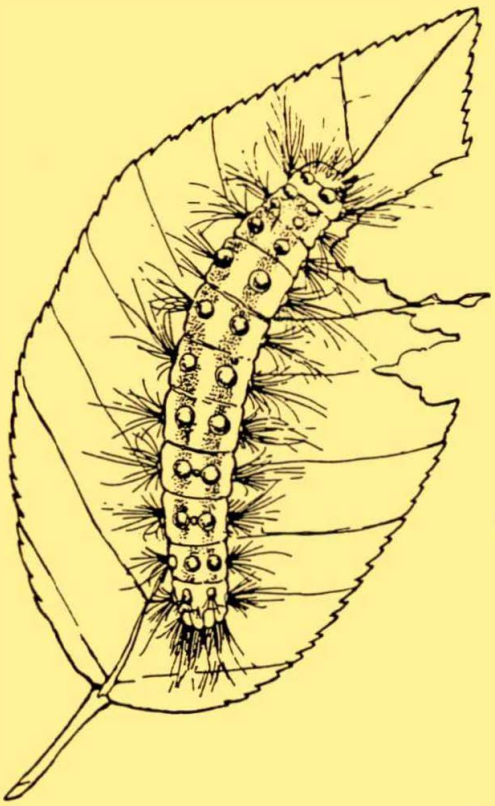
NORTH DAKOTA



FOREST PEST CONDITIONS

AND

SURVEY REPORT

NORTH DAKOTA STATE FOREST SERVICE

1992-93

See Page 29
Diagnosing Tree Problems
Using Injury Symptoms

NORTH DAKOTA

FOREST PEST CONDITIONS

AND

SURVEY REPORT

by

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NORTH DAKOTA FOREST SERVICE

Bottineau, North Dakota

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I. INTRODUCTION

From early May until October of 1992 and 1993, state-wide surveys for insect and disease pests of native and planted trees and shrubs were conducted in North Dakota. With the aid of USDA-Forest Service funding, 200 plus locations were inspected and more than 150 landowners were contacted in each of the two years. Technical assistance was also provided on pest identification, evaluation and control. This report summarizes forest insect and disease conditions for North Dakota in 1992 and 1993.

This publication was expanded to include diagnostic aids and references on forest insects and disease commonly found in North Dakota. This will be a valuable tool for natural resource professionals and landowners alike.

II. SURVEY METHODS

Pest survey methods included examination of representative samples from all major types of forest resources found in the state. Field investigations were conducted in native forests; shelterbelts; park and recreation areas; urban forests and other forested areas. The incidence of forest pests was recorded for each location. Special emphasis was placed on those pests recognized by resource professionals as having the greatest potential for causing significant damage to tree and shrub resources.

Particular attention was given to the incidence and impact of ash bark beetles and other wood boring insects. Moisture levels returned to near normal in most areas of the state in 1992, and far above normal in many areas in 1993. But lingering effects of the drought will be seen for as long as ten years, and some trees will never fully recover. Opportunistic insects and diseases will continue to take advantage of the stressed trees.

Technical assistance including identification, evaluation and control recommendations was provided to private landowners and resource managers when requested. In addition, 281 people were given training in 1992 and 560 attended training sessions in 1993. People that receive training over the years have become the "eyes and ears," in the field and feedback received from them is incorporated in this report. Survey information is presented periodically in the interim between reports to interested individuals and agencies involved in resource management. The North Dakota Urban and Community Forestry Association, North Dakota Farm Forestry Committee and the North Dakota Christmas Tree Grower's Association are given updates at their regular meetings.

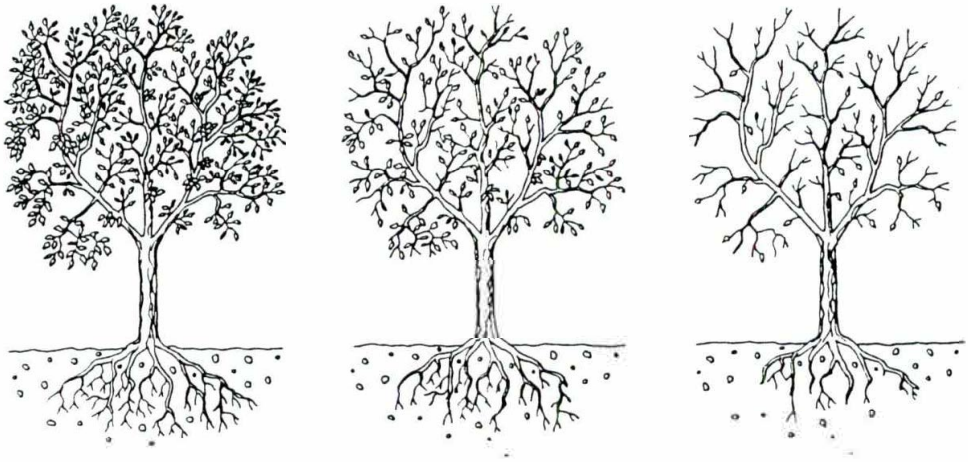
III. RESULTS

In each of the 1992 and 1993 field seasons, forest insect and disease conditions were evaluated in more than 200 locations across the state. More than 400 people, many seeking aid in pest identification and evaluation, were contacted. Considerable time was spent visiting groups with special interests in forest pest problems. Included were visitations to city foresters, park supervisors, nurserymen, researchers, SCS district conservationists, plant material specialists, North Dakota Game and Fish Department personnel and North Dakota Forest Service field foresters.

In addition to the public contacts made through this survey, North Dakota Forest Service personnel responded to 350 requests for forest pest management assistance in 1992 and 422 in 1993. Requests came primarily from community officials, urban home owners, private woodland owners and state and federal agencies. Many of these requests required on-site evaluation of pest conditions. Cultural, biological or chemical control recommendations were provided if needed.

IV. SPECIFIC PESTS

Section IV describes the specific forest pests most commonly encountered in 1992 and 1993. Table I - Section VII (page 21) and Table II - Section VIII (page 27) contain more extensive lists rating each pest by present and potential importance. The section also lists a reference and page number (example: R1-P15) that refers the reader to specific articles on the pest, and its biology.*



*** Section X - Annotated List of References (page 39) contains a list of reference books and publications detailing information specific to that insect or disease. These references are available at most County Extension, Soil Conservation Service, North Dakota Forest Service offices or local library. The page number in the reference book is provided to assist you in locating the information quickly. In most cases color photographs of the damage and the different life stages are included.**

BORERS AND BARK BEETLES

Ash Bark Beetles - Green ash and black ash
Eastern ash bark beetle; R3-P15, R5-P231, R8-P106.
Western ash bark beetle; R3-P15, R5-P231, R8-P106.

During the past several years, a number of resource managers have reported that relatively healthy green ash were being attacked, overwhelmed and killed by mass attacks of the ash bark beetle in the genus Hylesinus (formerly Leperisinus). This type of damage and mortality was found, but the numbers of incidences were low. Few trees are killed in this manner, certainly only a fraction of a percent statewide. All members of genus Hylesinus are considered secondary, attacking trees severely weakened by drought, suffering from lawn mower damage, soil compaction or other stresses. Because of the drought conditions experienced in 1988 and 1989, increased tree losses were seen during this period. More favorable moisture conditions since 1991 reduced over all losses to pre-drought period levels.

Although more than one species of bark beetle is involved, the primary species is the Eastern Ash Bark Beetle, Hylesinus aculeatus.

One member of the genus, Hylesinus californicus, the western ash bark beetle, damages green ash across the state. Younger, recently transplanted ash trees in parks, recreation areas and highway department plantings are especially hard hit. Stressed trees in any size class may be infested.

The western ash bark beetle, however, does not attack the main trunk of the tree en masse. This species prefers to attack live trees under stress, inflicting damage to individual limbs or the main stem in the crown. The formation of the brood gallery often girdles branches killing them from the point of attack outward. This species tends to re-infest the same trees year after year, progressively killing younger trees from the top downward. In larger trees, the crowns are progressively thinned until the tree loses its vigor, aesthetic value and ability to break the wind.

Pine Bark Beetle Complex (Ips and Dendroctonus) - Ponderosa pine
R1-P62, R5-P81, R3-P25, R5-P79.

In July 1988, scattered groups of recently killed trees were found in a native stand of ponderosa pine in Slope County. Closer inspection revealed groups of two to ten trees killed by bark beetles. These bark beetles were found to be in the genus Ips, commonly referred to as engraver beetles. This was the first time bark beetles had been reported killing ponderosa pine in the area.

The most prevalent species is the six-spined ips, Ips Calligraphus. Two other bark beetle species; the pine engraver, Ips pini, and the red turpentine beetle, Dendroctonus valens, were also present. The latter two were not detected in every tree. None of the three is considered highly aggressive, but each is capable of killing trees weakened by other factors. Populations since 1991 have persisted at relatively low levels, this is no doubt due to the return of adequate moisture. No further significant outbreaks are likely, unless drought conditions return.

Ash Borer (Lilac Borer) - Green ash and black ash
R1-P261, R3-P17, R5-P235.

Present in young green ash statewide, the ash borer is most prevalent in the southwest and south central areas of the state. Moderate populations were found in street trees in several cities and shade trees in parks, recreation areas and highway department plantings, especially in locations south and west of the Missouri River. Light to moderate infestations were noted in shelterbelts surrounding the Bowman-Haley Dam Reservoir.

Carpenterworm - Green ash, hybrid poplars, and Siberian elm
R1-P256, R3-P16, R5-P237.

Light to moderate populations appeared in green ash in southwest, south central and northwest North Dakota. Light to moderate populations also occurred in hybrid poplars in south central and southwestern North Dakota. Moderate damage occurred in the shelterbelts surrounding Bowman-Haley Reservoir. Larger green ash was the preferred host, with lesser populations in Siberian elm and hybrid poplars. Severe damage is common in both planted and native green ash south and west of the Missouri River.

Poplar Borer - Aspen, cottonwood, and hybrid poplars
R1-P284, R3-P19, R5-P229, R7-P81.

The poplar borer was most numerous in hybrid poplars in south central and southwestern North Dakota in parks and urban areas. Oftentimes, both the poplar borer and carpenterworms were present in the same trees (see carpenterworm).

This pest was also present in native aspen, causing extensive damage to open grown trees and trees along edges of fields, roads or lakes. Because the poplar borer seems to show a preference for laying its eggs in sunny locations, it may be wise to delay or avoid pruning hybrid poplars if possible. Native cottonwood is seldom affected by poplar borer.

Bronze Birch Borer - Birch
R1-P272, R5-P229.

Bronze birch borers continue to attack birch statewide, especially cutleaf weeping

birch weakened by drought or other factors. Drought conditions in 1988, 1989 and 1991 helped predispose many birch to attack, and there is likely to be continued losses over the next several years. Bronze birch borer infestations may be contributing to a continued decline of native birch in the state, but other factors are no doubt present.

Tip Borer - Scotch pine
R1-P48, R10-P84.

In 1989, larvae thought to be a species of Dioryctria were found tunneling in and killing the current year's growth, usually terminals, on Scotch pine. These insects were detected in McHenry, Cavalier and Pembina Counties. Highest populations were in Christmas tree plantations in Pembina County, but populations have not increased significantly. Because terminals are killed, this insect could be of major concern to Christmas tree growers if it were to occur in high numbers.

Tip Moth - Scotch and ponderosa pine
R1-P48, R3-P22, R8-P96.

The tip moth is most numerous on ponderosa pine in the south central and southwestern areas of North Dakota. It is occasionally found in the north central and northwestern areas of the state. The most severe damage was present on young natural reproduction in native stands in Slope County. Rarely has tip moth damage been observed north and east of a line extending from Crosby in the northwest to Ellendale in the southeast.

Two-Lined Chestnut Borer - Bur oak
R1-P270.

In August of 1990, large numbers of bur oak were reported dying at Sully's Hill Game Management Area near Devils Lake. The trees were being killed by the two-lined chestnut borer. Subsequently damage was found across the state. Heaviest losses were in the Edinburgh to Walhalla areas. Southeastern North Dakota escaped significant damage. As the 1991 season progressed, it became evident that tree kill would be reduced compared to the 1990 season. Since 1991, more favorable moisture conditions have allowed the trees to resist attacks. Populations continue to decline to the point where it was difficult to find infested trees in 1992 and 1993.

Metallic Pine Pitch Nodule Maker - Ponderosa, lodgepole, and Scotch pine
R3-P23, R8-P98.

The metallic pine pitch nodule maker is found statewide on ponderosa pine. Historically the heaviest populations have been found in the south central and southwest regions. Populations collapsed in 1992 and 1993. Factors responsible for the reductions in population are not known, but may relate to cool wet summers.

HARDWOOD DEFOLIATORS

Cankerworms - Elm, boxelder, green ash, linden, bur oak and hackberry
spring cankerworm; R1-P142; R3-P1, R8-P46.
fall cankerworm; R1-P142, R3-P1, R5-P175, R8-P43.

Again in 1992 and 1993, the perennial problem of defoliation of single row Siberian elm belts by the spring cankerworm was noted in many single-row Siberian elm plantings across North Dakota. Fall cankerworm occurs across the state and complete defoliation of green ash, boxelder and bur oak is common in both native stands and planted windbreaks.

An additional problem has been high populations of the fall cankerworm occurring simultaneously with spring cankerworm in some areas. Where both species occur, spring cankerworm defoliate elms, and the fall cankerworm defoliates green ash, boxelder, lindens and hackberry. Where only spring cankerworm exist, green ash, boxelder and understory shrubs usually escape heavy defoliation. Fall cankerworm has been noted in single row green ash in several areas.

Common associates of both species, especially in native areas are three other geometrid loopers: the linden looper, R1-P144 and R5-P177; elm spanworm, R1-P144 and R5-P144; and the half wing geometer (Phigalia titea), R1-P177 and R5-P179.

Populations of all species seem to rise and fall independent of each other in native, planted or urban areas.

Prairie Tent Caterpillar - Chokecherry, prunus, apples and wild rose
R1-P170, R3-P3, R5-P149, R8-P7.

The prairie tent caterpillar was common to locally abundant in the western two-thirds of the state. Chokecherry and wild rose are the preferred native species. Prairie tent caterpillar attacks occur in cities on prunus and apple species. Usually, very little actual defoliation occurs, but control measures are often taken because people consider the nests unsightly.

Pear Slug - Cotoneaster and prunus
R1-P130, R3-P6, R5-P199, R8-P29.

The pear slug has often caused complete defoliation of cotoneaster statewide. The central and north central areas of the state historically are the hardest hit. Pear slugs have two generations per year and it is generally the second generation that builds up to the most damaging levels. Pear slugs skeletonize leaves by consuming the upper surfaces causing the damage to superficially resemble fire blight injury. Consequently, the two pests are often confused.

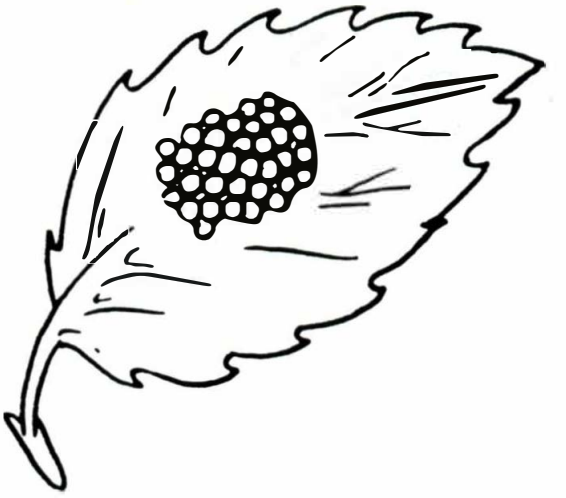
CONIFER DEFOLIATORS

Introduced Pine Sawfly - Scotch and ponderosa pine
R1-P16 R5-P35, R10-P42.

Scattered light to moderate infestations of introduced pine sawfly occurred on ponderosa and Scotch pine across the state, more commonly in the western half of the state.

Yellow Headed Spruce Sawfly - Blue and Black Hills spruce
R1-P18, R3-P13, R5-P33, R8-P26.

Scattered light to moderate infestations of yellow headed spruce sawflys were found on Blue and Black Hills spruces. Sometimes heavy defoliation occurs, mainly in the northern tier of counties. The geographical areas infested indicates a high likelihood that adults are being "blown in" from native spruce stands in Canada. Spruce cannot tolerate heavy defoliation, and a single heavy defoliation can kill them.



SAPSUCKING INSECTS AND MITES

Ash Plant Bug - Green ash
R1-P402, R3-P36, R5-P119, R8-P134

Damage by the ash plant bug was noted in planted and native ash statewide. Moderate to heavy damage was noted in all size classes of ash, but the most serious consequence were to young trees, especially those stressed by other factors.

Honeysuckle Witches-Broom Aphid - Tatarian honeysuckle
R1- P314, R3-P34, R5-P107.

Honeysuckle aphids seriously damaged Tatarian honeysuckle statewide, effectively stopping new growth and reducing the usefulness of Tatarian honeysuckle. The seriousness of the damage makes further usage of Tatarian honeysuckle questionable.

Aphids - Many species of trees and shrubs
R1-P13, R5-P107.

Severe damage was noted on aspen, hybrid poplars, oak, chokecherry, boxelder, green ash, American elm, snowball viburnum, spruces and Scotch pine. Aphid populations can rise very quickly and then, oftentimes, abruptly decline usually from predation, especially by ladybird beetles and their larvae. Detection of aphids requires close inspection on a regular basis. The presence of ants on the foliage generally means aphid infestation of the plant. Treatment may be required on young trees, especially if new growth is being affected and feeding damage threatens the form or vigor.

Giant Conifer Aphid - Scotch pine and ponderosa pine
R3-P39.

The giant conifer aphid was locally abundant on Scotch pine in south central and southwestern North Dakota. The insect was also present on Scotch and ponderosa pines, primarily in the western half of the state.

Pine Needle Scale - Pines and spruces, especially muhgo pine
R1-P108, R3-P38, R5-P41, R8-131, R9-P85.

The highest populations of pine needle scale were in the north central and south central areas of the state on muhgo pine and Black Hills spruce. Infestations are often missed or mis-diagnosed because of the difficulty of associating the tiny white specks with insect damage.

Spruce Spider Mite - Spruce, juniper and arborvitae
R1-P118, R3-P38, R5-P31.

High populations of mites were found in scattered locations throughout the state. Heavy rain and cool weather reduced populations in 1993. Generally, mites are restricted to localized protected areas and are not likely to be found uniformly over an entire large tree. Smaller trees are more likely to be seriously infected. Rain and high winds often dislodge the mites and their eggs. Open grown trees and shrubs are seldom seriously infested. Foundation shrub plantings are the most seriously affected, especially those sheltered by buildings or other types of structures. A separate species, the two-spotted mite, is often found on hardwood shrubs.

Diagnosis can be difficult and spider-mite damage is often confused with winter drying, drought stress, or other factors. Due to this mis-diagnosis, much needless spraying is done. This spraying may actually contribute to population buildups by eliminating predators.

Gypsy Moth
Larva

GALL MAKING INSECTS AND MITES

Ash Flower Mite Gall - Green ash
R3-P28, R8-P60.

Occurs on ash trees statewide, very noticeable in the winter when the galls turn blackish and persist on the trees. Although unsightly, the galls cause little, if any, actual damage to the trees. Male flowers are attacked with only occasional damage to female flowers or leaves.

Honey Locust Pod Gall Midge - Honey locust
R1-P466, R3-P30.

Locally abundant in Bismarck and Dickinson. Where it occurs it is persistant and numerous, causing new foliage to be re-infested repeatedly over the season.

Poplar Bud Gall Mite - Cottonwoods and other poplars
R3-P28, R5-P209.

Occurs statewide, found primarily on cottonwood and northwestern poplars and is particularly abundant on the later. The poplar bud gall mite may cause stunting, crooked growth and can contribute to the death of younger stressed trees.

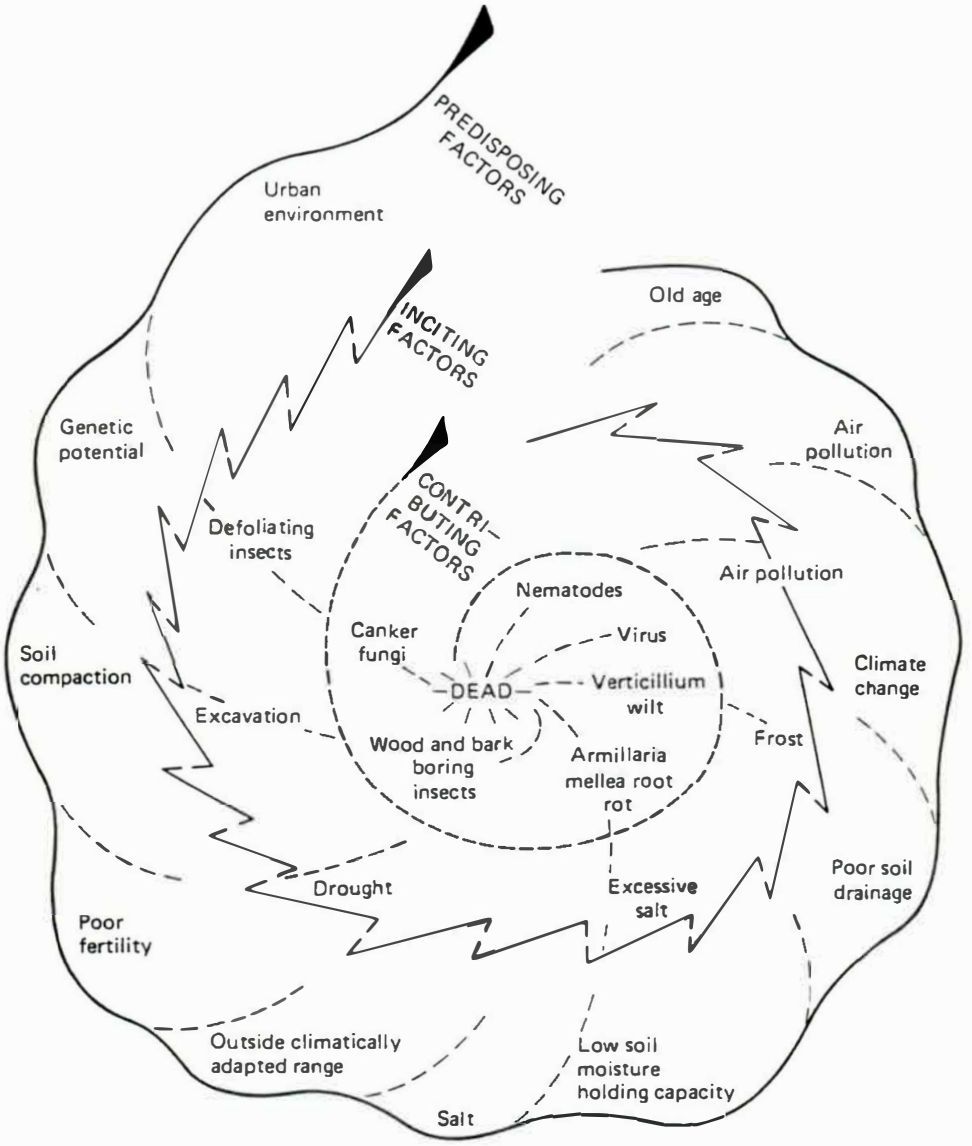
Poplar vagabond aphid - Cottonwoods and other poplars
R3-P30, R5-P209, R7-P95.

Occurs statewide, primarily objectionable because the relatively large galls persist throughout the season and are very noticeable after leaf drop. In reality, the trees suffer little, if any, actual physiological damage.

Oak Bullet Gall - Bur oak
R3-P30, R5-P213, R8-P74.

This gall was discovered to be abundant in Williston and sporadically in other areas primarily on small to medium sized planted oaks. Some individual trees had large numbers of galls on nearly every branch. Because the galls persist on the trees for up to five years, the resulting accumulation of galls is very unsightly. This gall is a potentially serious pest of bur oak in ornamental plantings.

V. DISEASES



Decline disease spiral.

HARDWOOD DISEASES

Dutch Elm Disease - American elm
R2-P366, R4-P92.

As of 1992 Dutch Elm Disease had spread to all of our major native stands of elms in the state. Only A few small pockets of native elms have escaped. The fate of planted elms is largely dependant on their proximity to infested native stands where the disease is easily transported to healthy trees by elm bark beetles. Once a tree is infected the disease can spread to healthy trees via natural root graphs. In cities, elm firewood piles that harbor bark beetles carrying DED spores are one of the most common means of spreading DED. However the incidence of disease was stable and, in some instances, even declined among cities with active sanitation and other management programs. As the disease runs its course in native elm stands, the risk of infection to nearby elms decreases.

Western X Disease - Chokecherry
R2-P392, R4-P24.

Western X disease symptoms occurred on native and planted chokecherry across the state. Symptoms include leaves that turn red in mid-summer, the lack fruit or fruit which does not ripen normally, and a distinct rosette of leaves on branch tips which produces reduction in growth and eventually death. Symptoms are present on common chokecherry in nearly every county, and also are found on the ornamental chokecherry variety known as Canada red cherry (Shubert chokecherry). While many factors can cause chokecherry to exhibit some of the symptoms characteristic of Western X disease, the presence of all of the above described symptoms on the same stem indicates a very high likelihood that Western X disease is present. Laboratory diagnosis is difficult, but samples submitted by Jim Walla of North Dakota State University to Dr. Bruce Kilpatrick of the University of California-Davis in 1989 confirmed Western X-disease present in Bottineau, Burleigh, Cass, Grand Forks and Pembina Counties.

Fire Blight - Apple, crabapple, pear and cotoneaster
R2-P162, R4-P76, R6-P99.

Fire blight is present statewide and remains a serious threat in susceptible varieties of apples and ornamental crabapples. A trend towards planting less susceptible varieties has reduced the severity. In less susceptible varieties injury may be restricted to the fruiting spurs instead of killing entire branches. All of the major cities experienced high infestation rates. The more isolated plantings in small towns, parks or farmsteads are not as likely to be seriously injured. Siberian crabapple trees in windbreaks may be seriously affected. Fire blight is found on cotoneaster statewide. An insect (see pear slug) causes symptoms which are often confused with fire blight. In the case of pear slug infestation, a close inspection will reveal skeletonizing on the upper surface of the leaf and the possible presence of larvae. While treatment with an

insecticide is an effective control for pear slugs, no pesticide is currently registered for fire blight control on cotoneaster.

Poplar Disease Cankers - Cottonwood and hybrid poplars

Septoria; R2-P74, R4-P50, R7-P37.
Cytospora; R2-P200, R4-P48, R7-P40.
Dothichiza sp.; R2-P184, R4-P54, R7-P40.
Phomopsis; R2-P142, R7-P40.

Disease cankers are an important cause of branch and stem mortality in hybrid poplars. Poplar clones vary widely in their genetic resistance to these canker diseases and ironically the native cottonwood that the hybrid poplars were meant to replace is the most resistant.

Siberian Elm Disease Cankers - Siberian elm

Tubercularia; R2-P208, R4-P40.
Botryodiplodia sp.; R2-P182, R4-P38.

Many shelterbelts, especially single-row, have been infected by disease cankers and are in a state of serious decline. These cankers are playing an important role in the deterioration process. Many miles of single-row Siberian elm shelterbelts are being removed each year, few are being replaced.

Russian Olive Disease Cankers - Russian olive

Botryodiplodia; R2-P180, R4-P42.
Tubercularia; R2-P208, R4-P40.
Phomopsis sp.; R4-P140, R4-P44.

Russian olive, especially shelterbelts in cultivated areas, continue to be plagued by branch dieback from cankers. Cankers seem to be more numerous on trees near cereal crops. This higher incidence may be related to more frequent direct exposure of trees to herbicides such as 2,4-D. Many healthy trees, some of them large and obviously quite old, continue to thrive in cities and parks where they have more room to grow and their exposure to crop sprays is lessened.

Black Knot - Chokecherry, Plums and Mayday

R2-P152, R4-P70, R6-P101.

Black knot disease appears to be on the increase on ornamentals prunus in cities. Canada red cherry is often attacked. When the diseased branches are not trimmed out, the incidence of disease increases year to year. Mayday trees seem to be particularly vulnerable and many have been removed because of deformities caused by black knot.

Native chokecherry is infested with black knot disease statewide. Some chokecherry clones are heavily infected with one or more knots present on nearly every branch. Where heavily infected chokecherry are in close proximity to ornamental

varieties of prunus, diseased plants should be removed.

Wetwood (Slime Flux) - Cottonwood, hybrid poplar and elm
R2-P382, R4-P64, R7-P52.

A high percentage of cottonwood, hybrid poplar and elm trees over approximately 30-years old are infected with bacterial wetwood. Outward signs of the disease are not always obvious. When wetwood toxins are transported into the branches of a tree's crown, wilting of the leaves may occur. Branch dieback and general tree decline can result. In some instances, wetwood has been judged to be the primary cause of decline or death of trees.

Cankers progress killing branches from bottom to top of tree

CONIFER DISEASES

Rhizophaera Needlecast - Blue spruce
R2-P42, R4-P124.

Rhizophaera needlecast on spruce increased largely because of the cool wet weather in 1992 and 1993 which favored spore production and germination. Historically rhizophaera is most prevalent in the eastern regions of the state, probably because of higher rainfall and humidity in the east. Spruce grown in crowded conditions are the most seriously affected.

Lirula Needlecast - Black Hills and white spruce
R2-P42, R6-P15.

Lirula needlecast disease was found primarily in north central, northeastern, and southeastern portions of North Dakota. A planting on the Wakopa Game Management area in Rolette County sustained light to moderate damage. Needlecast of spruce are more likely to affect sheltered trees (see Rhizophaera).

Unknown Tip Dieback - Scotch, mugho and ponderosa pines
Cenagium dieback; R2-P230

In 1988, 1989 and 1990, a characteristic tip dieback symptom was found on pines in the state. Damage occurred on the current year's growth. In some cases, the entire year's growth was dead. In other cases, all needles and bark tissue beyond a certain point were dead. No sign of insect activity or disease damage could be found. The symptoms closely resembled Cenangium dieback of pines, but cultures were negative. With the return to normal moisture conditions in 1991, this type of injury was rarely observed. A weak opportunistic fungus was believed to be involved, but the mystery remains.

Diplodia Tip Blight - Ponderosa pine
R2-P136, R4-P128, R9-P65, R10-P54.

In 1988 and 1989, Diplodia tip blight was identified in McHenry, Morton, Stark and Slope Counties. Since 1991 Diplodia has became much less prevalent.

Cytospora Canker - Spruce
R2-P196, R4-P132, R10-P53.

Cytospora canker caused damage to spruce mostly across the state. Older trees or trees stressed by sod competition, drought or root injury are especially susceptible to this canker. Any serious decline in the health of a tree may allow invasion of the organism. Infestations generally start with branches near the bottom of the tree. Crowding in the row or by adjacent trees has been implicated as a predisposing factor.

Western Gall Rust - Ponderosa and Scotch pines
R2-P282, R4-P126, R6-P51, R9-P27, R10-P73.

Western gall rust was found in pine plantations in McHenry, Bottineau, Pembina, Mercer and Morton Counties; several shelterbelts scattered throughout the state; and in native ponderosa pine in Slope County. The incidence of this disease is on the rise in planted ponderosa pine.

VI. ABIOTIC FACTORS

Herbicide Damage - Many species
R2-P456, R4-P33, R6-P118.

Herbicide injury has become an increasing problem for many tree species during recent years. In addition to the more "traditional" phenoxy herbicide injury (2,4-D drift), there has been increased damage from pre-emergent sprays. The list of approved herbicides for use on trees, shrubs, field crops and ornamentals grows every year. In some cases, injury symptoms of these herbicides on tree species is unknown. In addition, the source of the chemicals may not be obvious. Potentially harmful herbicides are sometimes added to "weed and feed" type lawn fertilizers or they may leach into the root zone of trees from nearby crops. Where variable soil and weather conditions exist, the application of herbicides according to label recommendations may cause injury to nearby trees.

Boxelder, Siberian elm, Amur maple and grape are particularly sensitive to 2,4-D injury. Direct herbicide application is not always necessary for these plants to show damage symptoms. Phenoxy herbicide injury has been implicated in the decline of Siberian elm, notable in single-row belts. Cottonwood seems to be especially sensitive to root injury by Tordon and other soil-applied chemicals. Extreme care and constant vigilance is needed to prevent herbicide and other chemical damage to trees and shrubs.

Fertilizer Damage - Many species

Conifers, especially spruce & pine in highly-fertilized lawns, seem to be more prone to winter damage. It is suspected that late summer or early fall applications of nitrogen keep them from going dormant when they should. No doubt, the same type of damage occurs on deciduous trees and shrubs, but is not as recognizable as damage to conifers.

Drought Damage - Manly species
R2-P340, R2-P476, R4-P88, R9-P98.

Effects of the severe drought in 1988-1991 will continue to affect North Dakota trees for several years to come. Trees were severely stressed and stressed trees are more prone to attack by insects and disease. Boring insects and bark beetles favor dry periods and weakened trees. Stressed trees are less able to resist invasion by canker causing fungi. In spite of better growing conditions since 1991, many trees will continue to decline. Effects of the drought will linger for several years to come.

Sapsuckers and other woodpeckers - Many species
R1-P500, R10-P83.

Sapsucker damage occurs most commonly on medium to large trees, but small

pines are commonly injured. Open areas of bark between whorls of branches are most often attacked. Damage consists of evenly spaced rows of holes which may extend all the way around the trunk. Because the holes are close together sap flow is interrupted and the stem is girdled above the point of injury. Sapsuckers are known to nest in the Turtle Mountains, Pembina Hills and other large tracts of native woodlands in the state. Damage may occur any time during the migration or breeding period in these regions. In the remainder of the state injury occurs only during the migration period.

Other species of woodpeckers excavate holes when they attempt to reach insect larvae that are tunneling in the wood or under the bark. These efforts, when noticed by humans, are oftentimes not appreciated and misinterpreted as willful damage by woodpeckers to trees. In some cases, the woodpecker pays with its life instead of being praised for its efforts to remove insect pests. Misguided home owners kill the birds not realizing that the woodpeckers are actually doing them a favor. Woodpeckers do not go around randomly drilling holes in trees! If woodpeckers are tunneling in your tree, insects are present. Tunneling activity uses up huge amounts of energy, and woodpeckers would not survive if they used this energy unwisely, especially in the winter. They must find high energy insect larvae to survive. The exception is when woodpeckers are excavating their nest holes. Even then, they choose trees with heart rot. Woodpecker activity should be used by home owners and other resource managers as a tip-off that their trees are severely stressed and wood boring insects have taken notice. Or in the case of nest holes, that heart rot or rotten areas are present.

IVORY-BILLED
WOODPECKER

VII. TABLE I - INSECTS

INCIDENCE AND POTENTIAL IMPORTANCE OF INSECTS

COMMONLY OCCURRING IN NORTH DAKOTA

KEY TO PLANTING TYPE AND DAMAGE RATING

Type of Forest or Planting	Present Incidence	Potential for increased or Sustained High Populations
URB - Urban	1 - High Population	A - High
SHL - Shelterbelts	2 - Moderate Population	B - Moderate
PRK - Parks	3 - Low Population	C - Low
NAT - Native	4 - Present, but insignificant	

PEST/HOST	CATEGORY AND DAMAGE RATING	COMMENTS
DEFOLIATING INSECTS		
Ash grey blister beetle/ caragana	URB-3B, SHL-2B, PRK-2B	
Aspen leaf roller/ native aspen	PRK-4C, NAT-3B	
Birch leaf miner/ birches	URB-4B, PRK-4B, NAT-4C	Eastern ND
Blackheaded ash sawfly/ green ash	URB-4C, SHL-4B, PRK-4B, NAT-4B	
Cecropia moth/green ash, boxelder, lilac, chokecherry	URB-4B, SHL-3B, PRK-3B, NAT-4B	
Cottonwood leaf beetle/ poplars, willows	URB-3B, SHL-4B, PRK-3B, NAT-3B	
Elm leaf beetle/ Siberian elm	URB-2A, SHL-4A, PRK-3A, NAT-3C	

PEST/HOST	CATEGORY AND DAMAGE RATING	COMMENTS
Elm sawfly/elms, white willow	URB-4B, SHL-3B, PRK-3B, NAT-4B	
European pine sawfly/ Scotch pine	URB-4B, SHL-3B, PRK-3B	
Fall cankerworm/ green ash, boxelder	URB-3B, SHL-3B, PRK-3B, NAT-2B	
Fall webworm/elms, prunus, populus,	URB-3C, SHL-3B, PRK-3B, NAT-2B	most numerous SW and SC
Forest Tent caterpillar/ aspen, ash, apples	URB-3B, SHL-4C, PRK-2B, NAT-3A	urban pest in larger cities
Fruit tree Leaf Roller/ green ash	URB-3B, SHL-4B, PRK-3B, NAT-4C	
Grasshoppers/ caragana	URB-4C, SHL-2A, PRK-2A	
Great ash sphinx/ green ash	URB-4B, SHL-4C, PRK-4B, NAT-4C	
Introduced pine sawfly/ ponderosa & Scotch pine	URB-4B, SHL-3B, PRK-3B, NAT-4B	
Larch sawfly/ Siberian larch	URB-4A, SHL-4A, PRK-3A	
Leaf crumpler/cotoneaster, hawthorne	URB-3B, SHL-3B, PRK-3B	
Linden looper/elm, oak boxelder, prunus	URB-3B, SHL-3B, PRK-2B, NAT-3B	commonly found with cankerworm
Mourningcloak butterfly (spiny elm caterpillar)/ elms	URB-3B, SHL-3C, PRK-2B, NAT-4C	
Pear slug/ prunus, cotoneaster	URB-1A, SHL-2A, PRK-2A, NAT-3B	especially in central & west on cotoneaster
Red humped oakworm/ bur oak	URB-4C, SHL-4C, PRK-4B, NAT-3B	

PEST/HOST	CATEGORY AND DAMAGE RATING	COMMENTS
Spring Cankerworm/ elms	URB-2A, SLH-1A, PRK-2B, NAT-2B	
Spruce budworm/ spruces	URB-4B, SHL-4B, PRK-4B	
Ugly nest tent caterpillar/chokecherry	URB-4B, SHL-3B, PRK-3B, NAT-3B	
Variable oak leaf caterpillar/burr oak	URB-4C, SHL-4C, PRK-4B, NAT-4B	
Yellow-headed spruce sawfly/spruces	URB-4B, SHL-4B, PRK-4B	NC & NE
HARDWOOD BORERS, BARK BEETLES, AND LEAF MINERS		
Ash borer/green ash lilacs,	URB-2A, SHL-3B, PRK-2A, NAT-3B	mostly young trees to 6" diameter
Ash & privet borer/ green ash	URB-3B, SHL-3A, PRK-3B, NAT-3B	
Boxelder twig borer/ boxelder	URB-2A, SHL-3A, PRK-3A, NAT-3B	
Bronze birch borer/cutleaf weeping birch, other birches	URB-1A, PRK-1A, NAT-2B	
Bronze poplar borer	URB-3B, SHL-3B, PRK-3B, NAT-4C	
Carpenterworm/green ash,	URB-3B, SHL-3B, PRK-2A, NAT-3B	mainly larger trees over 6" diameter
Cottonwood borer/ cottonwood, poplars	URB-4C, SHL-4C, PRK-4B, NAT-4C	
European elm bark beetle/elms	URB-4B, SHL-4B, PRK-4B, NAT-3B	

PEST/HOST	CATEGORY AND DAMAGE RATING	COMMENTS
Native elm bark beetle/ American elm	URB-2B, SHL-2B, PRK-2B, NAT-1A	
Peach bark beetle/ chokecherry, Juneberry, Mt. ash	URB-3B, SHL-2B, PRK-3B, NAT-3B	in dying trees
Peach tree borer/ prunus	URB-4B, SHL-3B, PRK-3B, NAT-3B	
Poplar borer/hybrid poplars, cottonwood, aspen	URB-3B, SHL-3B, PRK-2A, NAT-3B	prefers open grown trees
Poplar and willow borer	URB-4B, SHL-4B, PRK-4A, NAT-3A	NC & NE
Shothole borer/ chokecherry, Juneberry, Mt. ash, hawthorne	URB-3B, SHL-2B, PRK-3B, NAT-3B	in weakened trees
Two lined chestnut borer bur oak	URB-3B, SHL-4C, PRK-4C, NAT-2B	
CONIFER BORERS		
Larch case bearer	URB-4C, SHL-4B, PRK-4B	
Metallic pine pitch nodule maker/ponderosa pine	URB-3A, SHL-3A, PRK-2A, NAT-3B	
Pine needle sheath miner/ pines	URB-4B, SHL-3B, PRK-3B, NAT-4C	
Spruce needle miner/spruce	URB-4B, SHL-3B, PRK-4B	
Western pine tip moth/ ponderosa & Scotch pine	URB-4B, SHL-3A, PRK-2A, NAT-1B	SW & SC
Zimmerman pine moth/ ponderosa and scotch pine	URB-4B, SHL-4B, PRK-4B, NAT-4B	

PEST/HOST	CATEGORY AND DAMAGE RATING	COMMENTS
SAPSUCKING INSECTS & MITES		
Ash plant bug	URB-2B, SHL-1A, PRK-2B, NAT-2B	
Caragana aphid/caragana	URB-3B, SHL-3B, PRK-2B	
Chokecherry aphid/ chokecherry	URB-2B, SHL-2A, PRK-1A, NAT-3B	
Elm lace bug	URB-4B, SHL-4B, PRK-4B, NAT-4B	
European Elm Scale	URB-2A, SHL-3B, PRK-3B, NAT-3B	
European fruit lacanium scale/elms, green ash, boxelder	URB-3B, SHL-4C, PRK-3B, NAT-4C	
Giant conifer aphid/ ponderosa & Scotch pine	URB-3B, SHL-4B, PRK-3A, NAT-4C	
Honeysuckle witches'-broom aphid/Tatarian honeysuckle	URB-1A, SHL-1A, PRK-1A	
Lace bug/cotoneaster & Juneberry	URB-3B, SHL-4B, PRK-3B, NAT-3B	
Oak lace bug/Burr oak	URB-4C, SHL-4C, PRK-3B, NAT-1B	in native-oak areas
Oyster shell scale/prunus, cotoneaster, Juneberry	URB-2B, SHL-2B, PRK-2B, NAT-2B	
Pine needle scale/scotch & mugho pine, spruces	URB-2B, SHL-3C, PRK-2A	
Scurfy scale/ Poplars	URB-3B, SHL-3B, PRK-3B, NAT-4B	
Spruce Spider mite/spruce	URB-2B, SHL-3C, PRK-2B	protected sites or drought periods
Woolly elm aphid/ American Elm	URB-2A, SHL-3A, PRK-2A, NAT-3B	

PEST/HOST	CATEGORY AND DAMAGE RATING	COMMENTS
GALL MAKING INSECTS AND MITES		
Ash flower gall mite/ green ash	**URB-2B, SHL-2B, PRK-2B, NAT-2B**	
Eastern spruce adelgid/ spruces	**URB-4B, SHL-4B, PRK-4B**	
Hackberry nipple gall	**URB-3A, SHL-3A, PRK-3A**	
Oak Bullet Gall	**URB-2A, SHL-3B, PRK-3B, NAT-4C**	
Poplar bud gall mite	**URB-3B, SHL-2B, PRK-2B, NAT-2B**	
Poplar petiole gall aphid cottonwood	**URB-3B, SHL-3B, PRK-3B, NAT-3B**	
Poplar vagabond aphid gall/cottonwood	**URB-3B, SHL-3B, PRK-2B**	

VIII. TABLE II - DISEASES

INCIDENCE AND POTENTIAL IMPORTANCE OF DISEASES

COMMONLY OCCURRING IN NORTH DAKOTA

KEY TO PLANTING TYPE AND DAMAGE RATING

Type of Forest or Planting	Present Incidence	Potential for increased or Sustained High Populations
URB - Urban	1 - High Population	A - High
SHL - Shelterbelts	2 - Moderate Population	B - Moderate
PRK - Parks	3 - Low Population	C - Low
NAT - Native	4 - Present, but insignificant	

PEST/HOST	CATEGORY AND DAMAGE RATING	COMMENTS
HARDWOOD DISEASES		
Ash anthracnose green ash	URB-3A, SHL-3A, PRK-3A, NAT-3B	
Black knot chokecherry, Mayday	URB-2B, SHL-2B, PRK-2B, NAT-2C	
Cedar apple leaf rusts Hawthorn, Juneberry	URB-2A, SHL-2B, PRK-2B, NAT-3C	
Dutch elm disease American elm	URB-2A, SHL-3B, PRK-2A, NAT-1A	
Fireblight Apple, crab apple, cotoneaster	URB-2B, SHL-2B, PRK-2B, NAT-3C	
Poplar cankers Hybrid poplars	URB-2B, SHL-2A, PRK-2A,	

PEST/HOST	CATEGORY AND DAMAGE RATING	COMMENTS
Russian olive cankers Russian olive	URB-3B, SHL-2B, PRK-2B	
Siberian elm cankers Siberian elm	URB-2A, SHL-1A, PRK-2A	
Valsa canker Prunus sp.	URB-3B, SHL-3B, PRK-3B	
Western X disease Chokecherry	URB-2B, SHL-2B, PRK-2B, NAT-1B	
Wetwood Elm, cottonwood, hybrid poplar	URB-1A, SHL-1B, PRK-1A, NAT-2B	
CONIFER DISEASES		
Cedar apple rust juniper, cedar	URB-2B, SHL-2B, PRK-2B, NAT-3C	
Cytospora canker Spruce	URB-2B, SHL-2B, PRK-2B	
Diplodia blight Ponderosa pine	URB-4B, SHL-4B, PRK-4B, NAT-4C	
Lirula needleblight	URB-4B, SHL-3B, PRK-4B	
Rhizophaera needle cast Blue spruce	URB-3B, SHL-2B, PRK-3B	
Western gall rust Ponderosa pine	URB-3B, SHL-3B, PRK-3B, NAT-3C	

IX. DIAGNOSING TREE PROBLEMS USING INJURY SYMPTOMS

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INTRODUCTION

By comparing injury symptoms to examples listed in this guide, it is possible to identify over 140 specific insect, disease or abiotic tree and shrub problems. Following the name of the damaging agent is a reference and page number. To find the reference indicated refer to Section X, page 39. For the *"novice"* this gives a name and a means of identification, for those more familiar with tree problems, this guide may serve as a check list or as a reminder of less often encountered problems.

HOW TO USE THIS GUIDE

This guide is broken down by injury to conifers or deciduous trees and shrubs. Within each there are four major categories: **I. INJURY TO FOLIAGE, II. INJURY TO TWIGS OR NEW SHOOTS, III. INJURY TO TRUNKS OR LARGER BRANCHES and IV. ENTIRE TREE DYING.**

To identify a problem, determine the specific nature of the injuries and compare them with examples in the chart.

EXAMPLE: You notice that leaves are being eaten on your elm trees, and while examining the problem you disturb the foliage and caterpillars fall down and hang suspended on a silken thread.

TO IDENTIFY, GO TO: I. INJURY TO FOLIAGE

A. Leaves being eaten

4. No webbing, but larvae hang from a thread when the foliage is disturbed (cankerworms and associates).

IDENTIFICATION: elms: spring cankerworms; *R1-P142, R3-P1.*

Although a large percentage of the commonly encountered problems are included, keep in mind there are many that could not be included and new ones continue to appear every year.

Please feel free to contact the North Dakota Forest Service if you have questions. And please remember, the first step in control or problem evaluation is proper identification.

CONIFERS

DIAGNOSING TREE PROBLEMS USING INJURY SYMPTOMS

I. INJURY TO NEEDLES

A. Needles being eaten

1. **Webbing present,** (bud cap often retained by silk)
   spruce: spruce budworm; *R1-P28, R5-15, R8-43.* *
2. **No webbing**
   pine: introduced pine sawfly; *R1-P16, R5-P35, R10-P42.*
   European pine sawfly; *R1-P16, R3-P12, R5-P35, R10-P39.*
   spruce: yellow headed spruce sawfly; *R1-P18, R3-P13, R5-P33, R8-P26.*
   tussock moth; *R1-P26, R5-P18, R10-P44.*
   larch: larch sawfly; *R5-P37, R8-P26.*

B. Needles damaged or missing, but not consumed, may be off color or have discolored spots or bands or be mined out

1. **Spruce needles fade to purplish or brownish and fall off,** current years needles undamaged.
   Rhizophaera needlecast; *R2-P42, R4-P124.*
2. **Pine needles fading to yellowish and developing brownish spots or bands,** (second year or older needles); Nemacyclus, (Cyclaneusma) needlecast; *R2-P38, R4-P125, R10-P29.*
3. **Needles with small waxy white spots,** pines and spruce:
   pine needle scale; *R1-P108, R3-P38, R5-P41, R8-131, R9-P85.*
4. **Needles being mined out in the needle sheaths,**
   pines: tip moths; *R1-P48, R3-P22, R8-P96.*
   pine needle sheath miner; *R1-P38, R3-P10.*
5. **Needles mined out, usually a tiny hole visable,**
   spruce: spruce needle miners; *R1-P32, R3-P10, R5-P47, R8-P90.*
   larch: larch casebearer; *R1-P36, R5-P49, R8-P88.*
6. **Needles off color due to microscopic stippled areas, microscopic webbing may be present, individual mites very tiny, not usually visable to the naked eye except on a white background,**
   spruce, junipers, arborvitae: spider mites; *R1-P118, R3-P38, R5-P31.*
7. **Needles with brown spots or dead ends,**
   Pines: Lophodermium needlecast; *R2-P32, R6-P7.*
   winterburn; *R2-P480, R9-P97, R10-P36.*
   pesticide/herbicide damage; *R2-P456, R6-P118.*

* See page 39 for reference and page numbers.

8. **Second year needles turning uniformly reddish, fading to straw colored and remaining on the branch for several years, elongate black fruiting bodies may be present on dead needles:** spruces; Lirula needlecast, *R5-P15, R2-P42.*
9. **Annually in late summer or fall, second or third years needles uniformly turning brown to yellow and falling off (pines) or older branchlets of arborvitae turning reddish or brownish and falling off:** natural foliar shedding; *R2-P498.*

II. INJURY TO TWIGS OR NEW SHOOTS

A. Shoots dying, deformed or stunted

1. **New shoots stunted or dying**
   pines: Diplodia tip blight; *R2-P136, R4-P128, R9-P65, R10-P54.*
   Shoots dead, sometimes into 2nd year growth, live and dead areas sharply delimited, resin soaked at the boundary only.
   Scotch, mugho pine: cenangium dieback, *R2-P230.*
   spruce: white pine weevil; *R1-P54, R3-P23, R5-P73, R8-P96, R10-P68.*
   junipers: Kabitina tip blight; *R2-P138, R4-P116.*
2. **Buds and new shoots dying, being mined out**
   pines: pine tip moth; *R1-P48, R3-P22, R8-P96.*
3. **Buds being mined out, small pitch mass present**
   ponderosa pine: metallic pine pitch nodule maker; *R3-P23, R8-98.*
4. **Large aphids on twigs, branches or main stem**
   pines and spruce: giant conifer aphid; *R3-P39.*
5. **Single gall coosisting of large numbers of chambers, near the base of new shoots**
   spruce: Eastern spruce gall adelgid; *R1-P114, R3-P31, R5-P51, R8-P54, R9-P72.*
6. **Individual galls grouped together on stems**
   spruce: spruce gall midge; *R1-P116, R5-P45.*

III. INJURY TO TRUNKS OR LARGER BRANCHES

A. Injury to branches

1. **Entire branches dying, lower branches first**
   spruce: Cytospora canker; *R2-P196, R4-P132, R10-P53.*
2. **Woody galls on branches of pines, surface ruptures in the spring revealing an orange to yellowish spore mass**
   ponderosa and scotch pine: western gall rust; *R2-P282, R4-P126, R6-P51, R9-P27, R10-P73.*
   Irregular sized woody galls on junipers or cedars, may swell to large gelatinous mass in wet weather
   Junipers and cedars: cedar apple rust and other Gymnosporangium rusts; *R2-P240, R4-P136, R6-P82, R10-P71.*

Large pitch masses in branch whorls or on the trunks of pines, may cause branch failure or stem breakage, pitch masses turn yellowish with age
pines: Zimmerman pine moth complex; *R1-P48, R3-P24, R5-P85, R8-P98, R10-P84.*

3. **Medium sized, similarily shaped pitch masses, or pitch tubes, lower bole of tree**
pines: red turpentine beetle; *R1-P62, R3-P25, R5-P79.*
4. **Regular sized, evenly spaced rows of holes in the bark of the main trunk or large branches**
all species: sapsuckers (a woodpecker); *R1-P500, R10-P83.*
5. **Small regularily shaped tunnels under the bark, usually scoring both bark and wood, or a "shothole" pattern in the bark (bark beetles);** *R1-P250, R10-P82.*
pines: pine engravers,(ips sp), *R1-P62, R5-P81.*
spruces: spruce scolytus; prunus: shothole borer and peach bark beetle; *R1-P250.*
6. **Witches brooms, clusters of shoots all orginating near the same point**
junipers: cedar apple rusts; *R2-P240, R4-P136, R6-P82, R10-P71.*
pines: Western gall rusts; *R2-P282, R4-P126, R6-P51, R9-P27, R10-P73.*

IV. ENTIRE TREE DYING

A. Dying with needles on

pines: Ips bark beetles; *R1-P62, R5-P81.*
red turpentine beetle; *R1-P62, R3-P25, R5-P79.*
all species: chemical damage; *R2-P456, R6-120.*
herbicides or soil sterilents; *R2-P340, R2-P456, R4-P33.*
girdling by small rodents, beavers, or porcupines; *R6-122.*
also by mechanical damage from, lawn mowers, string trimmers, weed barriers, ice; *R2-P338*, girdling roots etc. *R2-488.*
drought damage; *R2-P340 & 476, R4-P88, R9-P98.*
winter injury; *R2-P478, R6-P115, R9-P97, R10-P38.*

HARDWOOD TREES & SHRUBS

DIAGNOSING TREE PROBLEMS BY USING INJURY SYMPTOMS

I. INJURY TO FOLIAGE

A. Leaves being eaten

1. **Webbing present, Larvae forage from silken nests**
   Chokecherry, Prunus, apples, wild rose: prairie tent caterpillar; *R1-P170, R3-P3, R5-149, R8-P7.* *
   Chokecherry: ugly nest tent caterpillar; *R1-P172, R3-P4, R5-P151.*
   Many species: fall webworm; *R1-P166, R3-P4, R5-P151, R8-P8.*
2. **Webbing present, no organized nest, but larvae rest on a silken mat placed on the trunk**
   Many species: forest tent caterpillar; *R1-P168, R3-P3, R5-147, R8-P34.*
3. **No webbing, larvae hang from a thread when the foliage is disturbed**
   (cankerworms and associates) elms: spring cankerworm; *R1-P142, R3-P1, R5-P175, R8-P46.*
   green ash, boxelder, bur oak: fall cankerworm; *R1-P142, R3-P1, R5-175, R8-P43.*
   Many hardwood species: cankerworms; *R1-P142.*
   linden looper; *R1-P144, R5-177.* elm spanworm; *R1-P144, R5-P177.*
   and the half wing geometer (phigalia titea) may be found in any combination on a particular host; *R1-P177, R5-P179.*
4. **No webbing, free feeding caterpillars;**
   Many species of trees and shrubs: there are dozens of species of moth, butterfly and caterpillar-like sawfly larvae that may be present. Trees and pests evolved together and light defoliation poses no threat to the host.
5. **No webbing, free feeding, but not caterpillars**
   caragana: blister beetles; *R3-P7, R5-P115, R8-P20.* grasshoppers; *R3-P7, R8-P24.* cottonwood, poplars, willow: cottonwood leaf beetle; *R3-P7, R5-P111, R7-P73, R8-P20.* elms: Elm leaf beetle; *R1-P222, R3-P6, R8-P23.*
6. **Leaves folded or tied, with a larvae inside**
   green ash, apples, many species: *R1-172, R1-214, R5-P165.*
   fruit tree leaf roller; *R1-P172, R3-P3, R5-P165, R8-P3.*
   oak: oak leaf roller, *R1-P214.* aspen: early aspen leaf roller; *R5-P167,* large aspen tortrix, *R1-P216, R5-P163, R7-P65.*

* See page 39 for reference and page numbers.

B. Leaves not eaten, but missing or falling and have discolored spots or dead areas on them

poplars and Caragana: Septoria leaf spot disease; *R2-P74, R4-P50, R7-P19.*
green ash: ash anthracnose; *R2-P70, R2-106, R4-P16.*
Mycosphaerella leaf spots; *R4-P14.*

C. Leaves present but damaged

1. **Upper surface of leaf consumed**
   cotoneaster, prunus: pear slugs; *R1-130, R3-P6, R5-P199, R8-P29.*
   elms: elm leaf beetle; *R1-P222, R3-P6, R8-P23.*
2. **Curled leaves with a woolly mass of aphids inside;**
   American elm: wooly elm aphid; *R1-P307, R3-P34, R5-P159, R8-P139.*
   woolly apple aphid; *R1-P306, R5-P159, R8-P139.*
3. **Aphids or aphid/like insects on underside of leaf, especially on new growth, aphids;** *R1-P13, R5-P107.*
   American elm: European elm scale (June/July only); *R1-P368, R3-P35.*
4. **Yellowish stippled areas on upper surface, black deposits underneath, small black and yellow bug**
   green ash: ash plant bug; *R1-P402, R3-P36, R5-P119, R8-P134.*
5. **Leaves bronzed or faded with black deposits** on underside, insects delicate in appearance
   Many species, especially elm, oak, hawthorne, juneberry and cotoneaster,
   lace bugs; *R1-P426, R3-P37, R5-P117, R8-P134.*
   spider mites, *R1-P472, R3-P37.*
6. **Bladder-like or warty growths** on either surface of the leaf, **(insect or mite galls)** *R5-P155.*
   America elm: elm leaf gall; *R1-464, R8-P67.*
   hackberry: nipplegall; *R1-452, R3-P28, R8-P58.*
   honeylocust: honeylocust pod gall midge; *R1-P466, R3-P30.*
   Many species: insect or mite galls; *R5-P155.*
7. **Oak leaves with dense woolly pile-like growths, colors vary from white to reddish or yellowish**
   bur oak: woolly oak gall wasp; *R8-P77.*
8. **Dense feltlike patches on the surface or depressions filled with feltlike hairs, (erineum), colors vary from green to brick red**
   boxelder, maples: erineum galls; *R1-483, R5-153.*
9. **Distorted new growth, smaller than normal cupped leaves with wavy margins**
   boxelder, Siberian elm: phenoxy herbicides; *R2-P458, R4-P33.*
   Many species: herbicide damage; *R2-P428, R4-P33, R6-P119.*

10. **Leaves mined between surfaces**
populus: leafmining sawfly; *R7-P68.*
elms: elm leafminer; *R8-P68.*
birch: birch leafminer; *R1-P184, R5-199.*

11. **Leaves with necrotic areas, sometimes joining to damage entire leaf**
green ash: ash anthracnose; *R2-P70 & 106, R4-P16.*
oak: oak anthracnose; *R2-P110, R4-P16.*

12. **Leaf spots, may have lighter colored centers,**
populus: Septoria; *R2-P74, R4-P8, R4-P50, R7-P19.*
Marssonia: *R4-P6, R6-P73, R7-P25.*
caragana: Septoria; *R4-P8.*
maples: Phyllosticta leaf spot; *R4-P10.*
prunus: leaf spots, may have holes in the leaves, fungal and bacterial leaf spots; *ND Ext. Bul. PP-689 "Diseases of Apples and Other Pome Fruits," R2-P66, R2-P160, R4-P22.* Western X-disease; *R2-P394, R4-P24.*
green ash: anthracnose; *R2-P70, R2-106, R4-P16.*
apples: frogeye leafspot (black rot), apple scab; *R2-P96.*
cedar apple rust; *R2-P240, R4-P136, R6-P83, ND Ext. Bul. PP-454 "Disease Control in Plums, Cherries and Other Stone Fruits."*

13. **Leaf spots, black spots resembling tar**
maples and willows: tar spot fungus; *R6-P91.*

14. **Leaves with yellowish or whitish dusty deposits**
lilac, Honeysuckle, poplars and willows: Powdery mildew; *R2-P14, R4-P30, R6-P81.* Melampsora leaf rusts; *R2-P256, R4-P4, R5-P79, R7-P20.*

15. **Leaf lesions, with hornlike structures, mainly on undersurface of leaf**
apples, hawthorn and Juneberry: cedar-apple rust; *R2-P240, R4-P136, R6-P83, ND Ext. Bul. PP-454.*

16. **Leaves develop early fall color, sparse foliage**
chokecherry: western x-disease; *R2-P24, R2-P322.*

17. **Leaves yellowing between veins, veins remain green**
maples, and others: chlorosis, mineral deficiency; *R2-P474, R4-P36.*

18. **Leaf margins scorched**
all species: especially lindens and maples
leaf scorch from hot winds; *R2-P476.* salt damage; *R2-P452.*

19. **Leaf petioles with marble like galls on them**
cottonwood, poplars: poplar petiole gall aphid; *R1-P460, R3-P29, R5-P157, R7-P107, R8-P69.*

20. **Frothy mass of spittle containing a small insect;**
Many species: spittlebugs; *R1-P240.*

II. INJURY TO TWIGS OR NEW SHOOTS

A. Shoots dying, deformed or stunted

1. **Shoots and leaves dying or deformed**
   Many species: aphids; *R1-P13, R5-P107, R8-P137.*
   herbicide damage; *R2-P458, R4-P33.*
2. **Witches' brooms**
   honeysuckle: honeysuckle aphid; *R1-P315, R3-P34, R5-P107.*
   Juneberry: black leaf witches' broom; *R2-P20, R5-P87.*
   oak: oak anthracnose; *R2-P110.*
3. **Shoots ending a with a convoluted "brain shaped" gall**
   cottonwood: vagabond aphid gall; *R3-P30, R5-P209, R7-P95.*
4. **Cauliflowerlike growth behind, or over buds**
   poplars: poplar bud mite gall; *R3-P28, R5-P209.*
5. **Black clusters hanging from twigs**
   green ash: ash flower gall mite; *R3-P28, R8-P60.*
6. **Large globular galls on twigs**
   rose: rose twiggall; *R8-P79.*
   oak: oak bullet gall; *R3-P30, R5-P213, R8-P74.*
7. **Twig terminating in a cone like structure**
   willows: pine cone willow gall; *R5-P213, R8-P54.*
8. **Swollen area on small twigs**
   boxelder: boxelder twig borer; *R5-P218, R8-P64.*
9. **Twigs dying, leaves blackened**
   apples, cotoneaster: fire blight; *R2-P162, R4-P76, R5-P99.*
   Juneberry: black leaf witches broom; *R2-P20, R5-P87.*

III. INJURY TO TRUNKS OR LARGER BRANCHES

A. Injury to branches

1. **Entire branch dying**
   American elm: Dutch elm disease; *R2-P366, R4-P92, R5-P105.*
   native elm wilt; *R2-P172, R4-P94.*
   apples, mountain ash, cotoneaster: fireblight; *R2-P162, R4-P76, R5-P99.*
   black rot canker; *ND Ext. Bul. PP-454 "Disease Control in Plums, Cherries and Other Stone Fruits."*
   aspen: Hypoxalon canker; *R2-P222, R4-P58, R6-P97, R7-P38.*
   chokecherry: Western X-disease; *R2-P392, R4-P24, ND Ext. Bul. PP-689 "Disease Control in Plums, Cherries and Other Stone Fruits."*
   green ash, black ash: Western ash bark beetle; *R3-P15, R5-P231.*
   poplars: Septoria; *R2-P74, R4-P50, R7-P37.* Cytospora; *R2-P200, R4-P48, R7-P40,* or Dothichiza cankers; *R2-P184, R4-P54, R7-P40.*

Siberian elm: Botryodiplodia canker; *R2-P182, R4-P38,*
tubercularia canker; *R2-P208, R4-P40.*
Russian olive: Botryodiplodia canker; *R2-P180, R4-P42.*
Tubercularia canker; *R2-P208, R4-P40.*
Phomopsis; *R2-P140, R4-P44.*
prunus: Valsa canker; *R2-P198.*

2. **Branches or trunk with small immobile spot like structures that can easily be dislodged, may occur singly, in irregular patches or cover large areas, color varies with the species, (scale insects)**
poplars: scurfy scale (white); *R1-P368, R5-P215, R7-P98.*
San Jose scale (grey); *R1-386.*
American elm: European elm scale; *R1-P368, R3-P35.*
Many hardwoods: lecanium scale (large-dark-brown); *R1-P364, R3-P364.*
Oystershell scale (small, elongate, grey-brown); *R1-P370, R3-P36.*

3. **Elongate thick blackish growths on branches**
chokecherry, prunus: black knot; *R2-P152, R4-P70, R6-101.*

4. **Holes in trunk of live or dying trees, meandering tunnels under the bark and sometimes into sapwood or heartwood, often associated with sawdust;**
green ash: lilac (ash) borer; *R1-P261, R3-17, R5-P235.*
carpenterworm; *R1-256, R3-P16, R5-237.*
poplars: poplar borer; *R1-P284, R3-P19, R5-225, R7-P81.*
bronze poplar borer; *R1-P272, R5-P229, R7-P85.*
oak: two lined chestnut borer; *R1-P270.*
birch: bronze birch borer; *R1-P272, R5-P229.*
Many species: poplar/willow borer; *R1-P268, R5-P221.*
pigeon tremex; *R5-P239, R1-P494.*

5. **Evenly spaced, evenly sized, rows of boles in the bark of the of thin barked species of trees**
Many species: sapsuckers (a woodpecker); *R1-P500, R5-P125.*

6. **Small regular tunnels under the bark, or shothole pattern in the bark (bark beetles)**
American elm: native elm bark beetle; *R1-P249, R3-P15, R5-227.*
European elm bark beetle; *R1-P249, R3-P15, R5-P227.*
green ash: Eastern ash bark beetle; *R3-P15, R5-P231, R8-P106.*
chokecherry, prunus: shothole borer and the peach bark beetle (bark beetle); *R1-P250.*

7. **Trunks or crotches oozing foul smelling sap, may kill vegetation where it drips**
elms, poplars: bacterial wetwood (slime flux); *R2-P382, R4-P64, R7-P52.*

8. **Trunks with shelf like or hoof-shaped growths, live but weakened or overmature trees.**
green ash: Perennipora (Fomes), heart rot fungus; *R2-P344, R4-P80.*
buffaloberry: Perennipora (fomes), heart rot fungus; *R4-P80.*
aspen: Phellinus heart rot fungus; *R2-P342, R4-P83, R6-P109, R7-P54.*

9. **Burl-like or gall-like growths on trunks and larger branches**
   cottonwood and poplars: Diplodia gall and rough bark of poplars (a fungus disease); *R5-P95.* many species: Crown Gall; *R4-P66.*
10. **Dead areas of bark extending vertically, usually on the south or west sides of main trunks**
    mountain ash, maples, lindens, Malus and others: sunscald, mainly due to late winter low angle sun; *R2-P478.*
11. **Vertical trunk cracks commonly referred to as frost cracks, but causes vary**
    many species: frost injury, drought damage, mechanical damage, improper pruning; *R2-P340, R4-P89.*
12. **Uniform dieback of top branches**
    all species: usually associated with root injury or death. Some common causes of root dieback are: oxygen starvation due to soil compaction or poor drainage, excessively dry soil, chemical damage, or mechanical injury, girdling roots (see below). Insects or diseases are only rarely responsible for significant root injury. Decline from multiple or unknown factor; *R2-P444.*
    birch decline; *R2-P448.*
13. **Bark on branches and/or main trunk blackened**
    American elm, and rarely other hardwoods:
    sooty mold fungus growing on "honeydew" produced by sapfeeding insects, most commonly woolly elm aphids and European elm scale on American elm.
14. **Witches Brooms or epicormic sprouts on the main trunk or basal flare**
    May be associated with tree decline: Ash yellows; *R2-P394.*

IV. ENTIRE TREE DYING

A. Dying with leaves on

American elm: Dutch elm disease; *R2-P366, R4-92.*
oaks: two lined chestnut borer; *R1-P270.*
birch: bronze birch borer; *R1-P272, R5-P229.*
chokecherry: Western X-disease; *R2-P392, R4-P24, ND Ext. Bul. PP-689 "Disease Control In Plums, Cherries and Other Stone Fruits."*
Many species: girdling by: canker diseases, small rodents, beavers, or porcupines, mechanical damage from: lawn mowers, string trimmers, weed barriers. Trees may be girdled by their own roots, this may be indicated by a lack of root flare above the girdling portion of the roots of larger trees; *R2-P488.* Drought damage; *R2-P340, R2-P476.*

X. ANNOTATED LIST OF REFERENCES

1. "INSECTS THAT FEED ON TREES AND SHRUBS"
Johnson, Warren T. and Howard H. Lyon.
1976, 1988. Comstock Publishing, a Division of Cornell University Press, ISBN 0-8014-0956-X, 464 pages, 212 color plates, 32 figures.

Note: This book is, with its companion volume "Diseases of Trees and Shrubs," (see reference 2), should be in every reference collection. Color plates of the damage and all important life stages make these references easy to use for even the layman. Information in both volumes is arranged not as a taxonomic guide, but as a field guide. Both volumes are in print and readily available. More than 650 species of insects that can damage over 200 species of woody plants are covered.

2. "DISEASES OF TREES AND SHRUBS"
Sinclair, Wayne A., Howard H. Lyon, and Warren Johnson.
Comstock Publishing, a Division of Cornell University Press, ISBN 0-8014-1517-9, 574 pages, 247 color plates.

Note: (see reference 1) The color plates contain more than 1700 illustrations of the diseases and injuries that some 350 biological agents and environmental factors cause to more than 250 species of plants.

3. "COMMON INSECT PESTS OF TREES IN THE GREAT PLAINS"
Dix, Mary Ellen, Judith Pasek, Mark Harrell, and Frederick P. Baxendale; Technical Coordinators. 1986. Great Plains Agricultural Council Publication No. 19, Nebraska Cooperative Extension Service EC 86-1548 (Cooperative effort of USDA Forest Service, Rocky Mountain Forest and Range Experiment Station and University of Nebraska Cooperative Extension Service.

Note: This publication was developed by entomologists on the GPAC Pest Management Task Force and is highly relevant to North Dakota. It is designed for those with no formal training in entomology. There was a general distribution to Soil Conservation Service and Extension offices. This reference is still available through Nebraska Extension Service.

4. "DISEASES OF TREES IN THE GREAT PLAINS"
Riffle, Jerry W. and Glenn W. Peterson, Technical Coordinators.
Gen. Tech. Rep. RM-129. Fort Collins, Co: U.S. Dept of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1986, 149 pages.

Note: This reference covers 46 hardwood and 15 conifer diseases present in the Great Plains and is one of the most valuable texts on diseases present in North Dakota.

5. **"TREE AND SHRUB INSECTS OF THE PRAIRIE PROVINCES"**
Ives, W.G.H., and H.R. Wong.
Canadian Forestry Service, Northern Forestry Center, Edmonton Alberta.
Information Report NOR-X-292, 1988.

Note: More than 600 species of insects and mites that feed on trees and shrubs in the prairie provinces are discussed in terms of their damage, life cycle, distribution and appearance. There are approximately 1100 color photographs. A valuable reference for North Dakota.

6. **"FOREST TREE DISEASES OF THE PRAIRIE PROVINCES"**
Hiratsuka, Y.
Canadian Forestry Service, Northern Forestry Center, Edmonton Alberta.
Information Report NOR-X-286, 1987.

Note: The major forest tree diseases of the prairie provinces are described in terms of their cause, distribution and hosts. The 25 coniferous, 15 deciduous are illustrated by color photographs. A very good reference for our area.

7. **A Guide to Insect, Disease and Animal Pests of Poplars"**
Ostry, Michael E., Louis Wilson, Harold S. McNabb Jr., Lincoln M. Moore.
Agricultural Handbook 677. Washington, DC: U.S. Dept. of Agriculture.

Note: Describes and illustrates, (color photos), the major insects, diseases and animal pests of poplars. Provides information on the identification, biology and control of casual agents. Emphasizes field identification and provides references for further information.

8. **"Key to Shelterbelt Insects in the Northern Great Plains"**
Stein, John K. and Patrick C. Kennedy.
USDA Forest Service Research Paper RM-85, Page 153, 1972.
Rocky Mountain Forest and Range Experimental Station, Fort Collins, Colorado.

Note: Contains a key to 227 insect pests. The key contains 235 photos, drawings and four tables which make this a valuable tool for anyone.

9. **"Field Guide to Disease and Insect Pests of Idaho and Montana Forests"**
Hagle, Susan K., Scott Tunnock, Kenneth Gibson, and Carma Gillagan.
USDA Forest Service, State and Private Forestry, Northern Region. PO Box 7669, Missoula, Montana 59807, 1987.

Note: Contains keys, color pictures and descriptions of conifer pests in the Northern Region. A valuable reference for conifer insect, disease pests and abiotic conditions.

10. **"Christmas Tree Pest Manual"**
USDA Forest Service, North Central Forest Experimental Station, St. Paul, MN: Page 108, 1983.

Note: Color photographs and descriptions of 70 Christmas tree pests will help growers and others to identify the causes of various tree injury. Describes ways to prevent or reduce damage from insects, diseases, birds, mammals and environmental factors. Excellent conifer reference for the north central area.

XI. LIST OF COMMON AND SCIENTIFIC NAMES

INSECTS	*SCIENTIFIC NAME*
Ash borer (lilac borer)	Podosesia syringae
Ash and privet borer	Tylonotus bimaculatus
Ash flower gall mite	Eriophyes fraxiniflora
Ash plant bug	Neoborus amoenus
Aspen leafminer	Phyllocnistis populiella
Blackheaded ash sawfly	Tethida cordigera
Blister beetles	Epicauta sp.
Ash gray blister beetle	Epicauta fabricii
Caragana blister beetle	Epicauta subglabra
Boxelder twig borer	Proteoteras willingana
Bronze poplar borer	Agrilus liragus
Bronze birch borer	Agrilus anxius
Caragana aphid	Acyrthosiphon caraganae
Caragana blister beetle	Epicauta subglabra
Carpenterworm	Prionoxystus robiniae
Cecropia moth	Hyalophora cecropia
Chokecherry aphid	Aphis cerasifolia
Cottonwood borer	Plectrodera scalator
Cottonwood leaf beetle	Chrysomela scripta
Eastern ash bark beetle	Hylesinus aculeatus
Eastern spruce gall adelgid	
Early aspen leaf roller	Pseudexentra oregonana
Elm lacebug	Corythucha ulmi
Elm leaf beetle	Pyrrhalta luteola
Elm leafminer	Fenusa ulmi
Elm sawfly	Cimbex americana
European elm bark beetle	Scolytus multistriatus
European elm scale	Gossyparia spuria
European fruit lecanium	Lecanium corni
European pine sawfly	Neodiprion sertifer
Fall cankerworm	Alsophila pometaria
Fall webworm	Hyphantria cunea
Forest tent caterpillar	Malacosoma disstria
Fruittree leafroller	Archips argyrospilus
Giant conifer aphid	Cinara species

INSECTS	*SCIENTIFIC NAME*
Grasshoppers	Melanoplus species
Great ash sphinx	Sphinx chersis
Hackberry nipplegall maker	Pachypsylla celtidismamma
Honeylocust pod gall midge	Dasineura gleditchiae
Honeysuckle witches broom aphid	Hyadaphis tataricae
Introduced pine sawfly	Diprion similis
Lace bugs	Corythucha species
Larch casebearer	Coleophora laricella
Larch sawfly	Pristiphora erichsonii
Leaf crumpler	Arobasis indigenella
Lecanium scale	Lecanium corni
Linden looper	Erannis tiliaria
Metallic pine pitch nodule maker	Retinia metallica
Mourningcloak butterfly	Nymphalis antiopa
Native elm bark beetle	Hylurgopinus rufipes
Oak bullet gall	Disholcaspis quercusmamma
Oak lace bug	Corythucha arcuata
Oystershell scale	Lepidosaphes ulmi
Peach bark beetle	Phloetribus liminaris
Peach tree borer	Synanthedon pictipes
Pear slug	Caliroa cerasi
Pigeon tremex	Tremex columba
Pine cone willow gall	Rhabdophagus strobiloides
Pine engraver bark beetles	Ips sp. (calligraphus & pini)
Pine needle scale	Chionaspis pinifoliae
Pine needle sheathminer	Zelleria Heimbachi
Pine tip moths	Rhyacionia species
Poplar and willow borer	Crypthorhnchus lapathi
Poplar borer	Saperda calcarata
Poplar bud gall mite	Aceria parapopuli
Poplar petiole gall aphid	Pemphigus populitransversus
Poplar vagabond aphid	Mordwilkoja vagabunda
Prairie tent caterpillar	Malacosoma californicum lutescens
Red humped oakworm	Symmerista albifrons
Red turpentine beetle	Dendroctonus valens
Rose twiggall	Diplolepsis spinosa
San Jose scale	Quadraspidiotus perniciosus
Scurfy scale	Chionaspis species
Shothole borer	Scolytus rugulosus
Smaller European elm bark beetle	Scolytus multistriatus
Spider mites	Oligonychus species, Tetranychus species & Eotetranychus species

INSECTS	*SCIENTIFIC NAME*
Spring cankerworm	Paleacrita vernata
Spruce budworm	Choristoneura fumiferana
Spruce needleminer	Endothenia albolineana
Spruce gall midge	Mayetiola piceae
Spruce spider mite	Oligonychus unuguis
Tip borer, Scotch pine	Dioryctria species
Tip moths	Rhyacionia species
Two lined chestnut borer	Agrilus bilineatus
Tussock moth	Parorgyia grisefacta
Uglynest caterpillar	Archips cerasivorana
Variable oakleaf caterpillar	Heterocampa manteo
Warty leafgall	Aceria negundi
Western ash bark beetle	Hylesinus californicus
Western pine tip moth	Rhyacionia bushnelli
White-banded ash bark beetle	Hylesinus fasciatus
White-spotted pine sawyers	Monochamus scutellatus
Woolly elm aphid	Eriosoma americanum
Yellow-headed spruce sawfly	Pikonema alaskensis
Zimmerman pine moth complex	Dioryctria ponderosae, Dioryctria tumicolella Dioryctria zimmermani

DISEASES	*SCIENTIFIC NAMES*
Anthracnose (ash)	Gloeosporium aridum
Anthracnose (oak)	Gnomonia quuercina
Black knot	Apiosporina morbosa
Black rot (frogeye leafspot)	Physalopora obtusa
Cedar apple rust	Gymnosporangium sp.
Cytospora canker (spruce	Cytospora kunzei
Diplodia tip blight (pines)	Diplodia pinea
Dutch elm disease	Ceratocystis ulmi
Fireblight	Erwinia amylovora
Frogeye leafspot (blackrot)	Physalopra obtusa
Kabatina tip blight	Kabatina juniperi
Nemacyclus (Cyclaneusma) needlecast	Naemacyclus minor
Poplar cankers	Cytospora sp.
	Phomopsis sp.
	Dothichiza populea
	Septoria musiva
Rhizosphaera needlecast	Rhizosphaera kalkhoffii
Russian olive cankers	Botryodiplodia theobromae
	Tubercularia ulmea
	Phomopsis arnoldiae
Siberian elm canker	Botryodiplodia hypodermia
	Tubercularia ulmea
Sooty mold	Unknown sp.
Valsa canker	Valsa sp.
Western gall rust	Endocronartium harknessii
Western X disease	A Mycoplasma like organism (MLO)
Wetwood	Enterobacter cloacae

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